Memo

To: Seattle Public Utilities

Cc: Dustin Ong, SE

From: Mike Helminger, PE

Date: February 4, 2013

RE: WA #4 – NE 93rd Street Culvert Repair

Basis of Design Memo

The purpose of this Basis-of-Design (BOD) Memorandum is to outline the design approach and set basic design criteria for the NE 93rd Street Culvert Repair Project. The BOD is a working document that will be updated as necessary to reflect changes to the project.

1. Project Description

The culvert, which conveys Thornton Creek, is located on NE 93rd Street, approximately 150-feet east of Sand Point Way NE, in northeast Seattle near the entrance to Matthews Beach Park. More specifically, the culvert is situated between the King County Mathews Beach Pump Station to the northwest and private residences to the south. See Figure 1 for details.

A culvert assessment prepared by Osborn Consulting (OCI) in July 2012 identified the failure mechanism and the extent of failure, factoring in local property and life safety risks to arrive at an overall hazard rating for the culvert. The assessment also provided potential repair options for Seattle Public Utilities (SPU) to review. A January 2013 peer review by Kennedy Jenks (KJ) of the repair options supported the selection of an H-Pile repair option that will support one-half of the culvert, which is experiencing displacement due to undermining of the culvert footing.

Figure 1 – Project Location

1.1. Project Goal

As part of the SPU long term plan, SPU is incrementally upgrading and replacing its culvert network to address an aging system. Because of factors related to permitting and land procurement, repairing this culvert, as opposed to replacing it, was deemed the most appropriate course of action given its current structural state.

Therefore, the primary goal of this project is to design a repair with a life expectancy of at least 10 years, while SPU evaluates options for a long term solution acceptable to the City, the neighborhood and the Washington Department of Fish and Wildlife (WDFW).

1.2. Project Objectives

- Stabilize the culvert to extend the structure's life.
- Avoid in-water work to minimize the length of the permitting process and to maximize the chance of early construction.
- Keep NE 93rd Street open to neighborhood traffic during construction.
- Avoid adversely impacting the quality of the Creek water (from sediment and/or concrete runoff)
- Avoid vibration damage to the neighboring houses.
- Keep the neighborhood informed on progress and schedule.

1.3. Scope and Limitations

- The scope is limited to the repair of this culvert; work will not include additional analysis of alternative repair options, design or permitting for a culvert replacement.
- The project is scoped to meet permitting requirements for repairs from the Army Corps of Engineers (ACOE), WDFW and the Seattle Department of Transportation (SDOT).

2. Applicable Design Codes, Standards, and Regulations

The design will be based on the most current codes and standards as provided below. The design will examine only the new pile support system to ensure the culvert meets the level of service of the original culvert structure to support the road and maintain fish passage..

2.1 Codes and Standards

- City of Seattle Standard Specifications for Road, Bridge and Municipal Construction, 2011 Edition
- City of Seattle Standard Plans for Municipal Construction, 2011 Edition
- City of Seattle Right of Way Improvements Manual
- City of Seattle Stormwater Manual Volume 2 and 3 SPU DR 2009-004 & 2009-005
- City of Seattle Environmental (SEPA) Checklist
- Street and Sidewalk Pavement Opening and Restoration SDOT DR 5-2009
- WSDOT Geotechnical Design Manual, 2011 Edition
- AASHTO Standard Specifications for Bridge Construction, 17thEdition
- WDFW –Hydraulic Project Approval (HPA) per Chapter 77.55 RCW and Chapter 220-110 WAC

2.2 Deviations from Standards

There are no known deviations from the Standards at this point in the design phase.

2.3 Identified Permit Reviews

- City of Seattle Environmental Review – SEPA
- SDOT Review – Utility Major Permit
- WDFW and ACOE- HPA

3. Design Approach and Information

3.1. Design Concept and Constructability

The intent of the design is to support the east wall of the culvert, which has been identified to be undermined and settling, while not requiring in-water work. Drilled H-Piles will be installed at roughly 8-ft on-center along the entire length of the east wall; spacing will be modified to avoid utilities and other site interferences. The Contractor will locate the edge of the east wall footing by potholing. Once the edge of the footing has been located, the Contractor will be able to drill the shafts for the piles. Drilled shafts are being used for this project because it will reduce potential adverse effects of vibration to neighboring properties. Monitoring requirements will be included in the Plans to notify the construction Contractor of its responsibilities to avoid damage to adjacent properties. Holes will be drilled in a sequence, determined by the Contractor, to maintain limited road access. The Contractor will excavate a narrow trench in the roadway to allow worker access to the base of the footing at each pile location. The design of all temporary shoring is the responsibility of the Contractor.

To stabilize the culvert, the following work will be performed. A series of expansion anchor bolts will be installed into the footing. Holes for thru-rods will be drilled at this time as well, but will be installed later in the process. Next, the shaft will be drilled and the Contractor will install casing to prevent water from Thornton Creek from entering the work area; the casing will also prevent material from escaping into Thornton Creek. The pile will be placed in the shaft and either controlled density fill (CDF) or concrete will be placed into the hole up to the depth of the footing. Thru rods will be installed between the pile and the culvert wall and the remaining open drilled shaft will be filled with structural concrete. The Contractor will repair the area above the roadway temporarily with cold-mix asphalt or cover it with a trench plate, and move onto the next pile location to repeat the process until all piles have been installed. Once all structural elements are completed, the area will be restored in accordance to SDOT standard plan for roadway restoration.

3.2. Design Information

Design loads shall be as follows:

- Dead: Weight of all structures
- Live: 85 pounds per square foot (PSF) pedestrian
- Vehicle:
    - HS-20 Design Truck
    - 64 PSF lane load for each 10’ wide lane
- Seismic: Per geotechnical design parameters below
- Earth Pressure: Per geotechnical design parameters below

Geotechnical design parameters will be based on the Geotechnical Recommendations Memorandum prepared by SPU Geotechnical Engineering dated January 23, 2013. Key parameters for design purpose are listed below in Tables 1-4. Refer to the Memorandum for additional recommendations.

Table 1 - Seismic Design Parameters – Site Class D

Design Parameter	Short Period (g)	Long Period (g)
Mapped Spectral Acceleration	S_s = 1.23	S_1 =0.42
Site Coefficients	F_a = 1.01	F_v = 1.58
Maximum Considered EQ Spectral Response Acceleration	S_{MS} = 1.24	S_{M1} = 0.67
Design Spectral Response Acceleration	S_{DS} = 0.83	S_{D1} = 0.44

Table 2 - Soil Design Parameters

Anticipated Soil Unit	Moist Unit Weight, ϒ (pcf)	Saturated Unit Weight, ϒ (pcf)	Effective Strength Parameters	
			Friction Angle, ϕ (deg.)	Cohesion, c (psf)
Very loose silty sand to very soft silt	90	105	28	0
Medium dense to very dense silty sand, stiff to very stiff sandy silt	120	125	34	0
Hard silt	125	130	38	300

Table 3 - Static Lateral Earth Pressures

Anticipated Soil Unit	Approximate Depth Below Ground Surface (ft)	Active Pressure (psf/ft)	At-Rest Pressure (psf/ft)
Very loose silty sand to very soft silt	0 – 15	40	60
Medium dense to very dense silty sand, stiff to very stiff sandy silt	15 – 25	34	54
Hard silt	> 25	30	48

Table 4 - Nominal Axial Unit Pile Capacities

Anticipated Soil Unit	Approximate Depth Below Ground Surface (ft)	End Bearing (ksf)	Side Friction (ksf)
Very loose silty sand to very soft silt	0 – 15	Not Recommended	Not Recommended
Medium dense to very dense silty sand, stiff to very stiff sandy silt	15 – 25	15	1.1
Hard silt	> 25	50	1.5

4. Additional Project Documents

In addition, refer to the latest addition of the following documents

- Project Risk Register, by SPU
- Project Schedule, by SPU
- Peer Review Letter, dated January 9, 2013, by Kennedy Jenks
- Geotechnical Recommendations Memorandum, dated January 23, 2013, by SPU Geotechnical Engineering

5. Preliminary Design Sketches

Shown below are Figures 2 and 3. They show the preliminary design concept for the culvert repair.

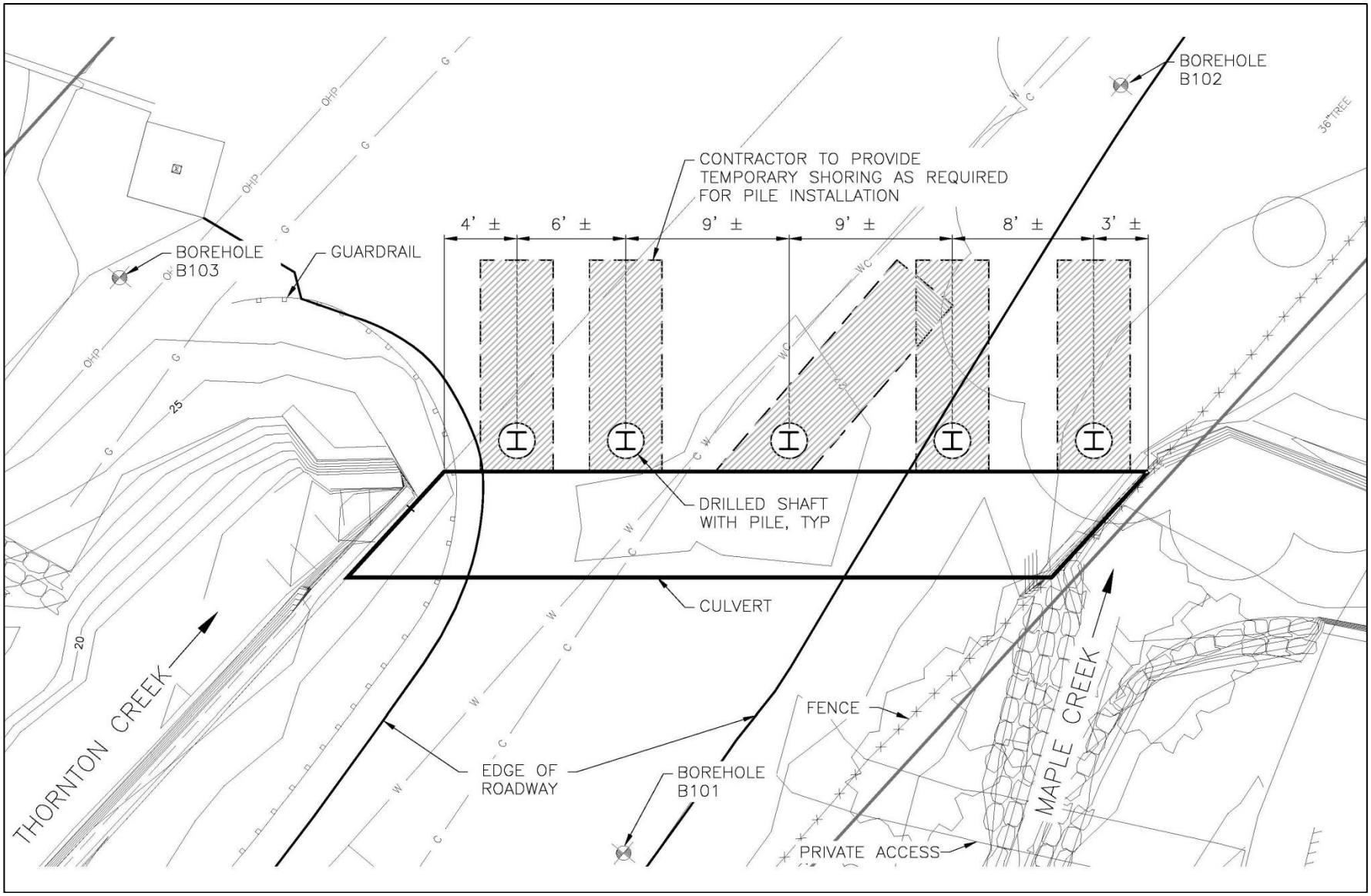

Figure 2 – Preliminary Sketch – Plan View

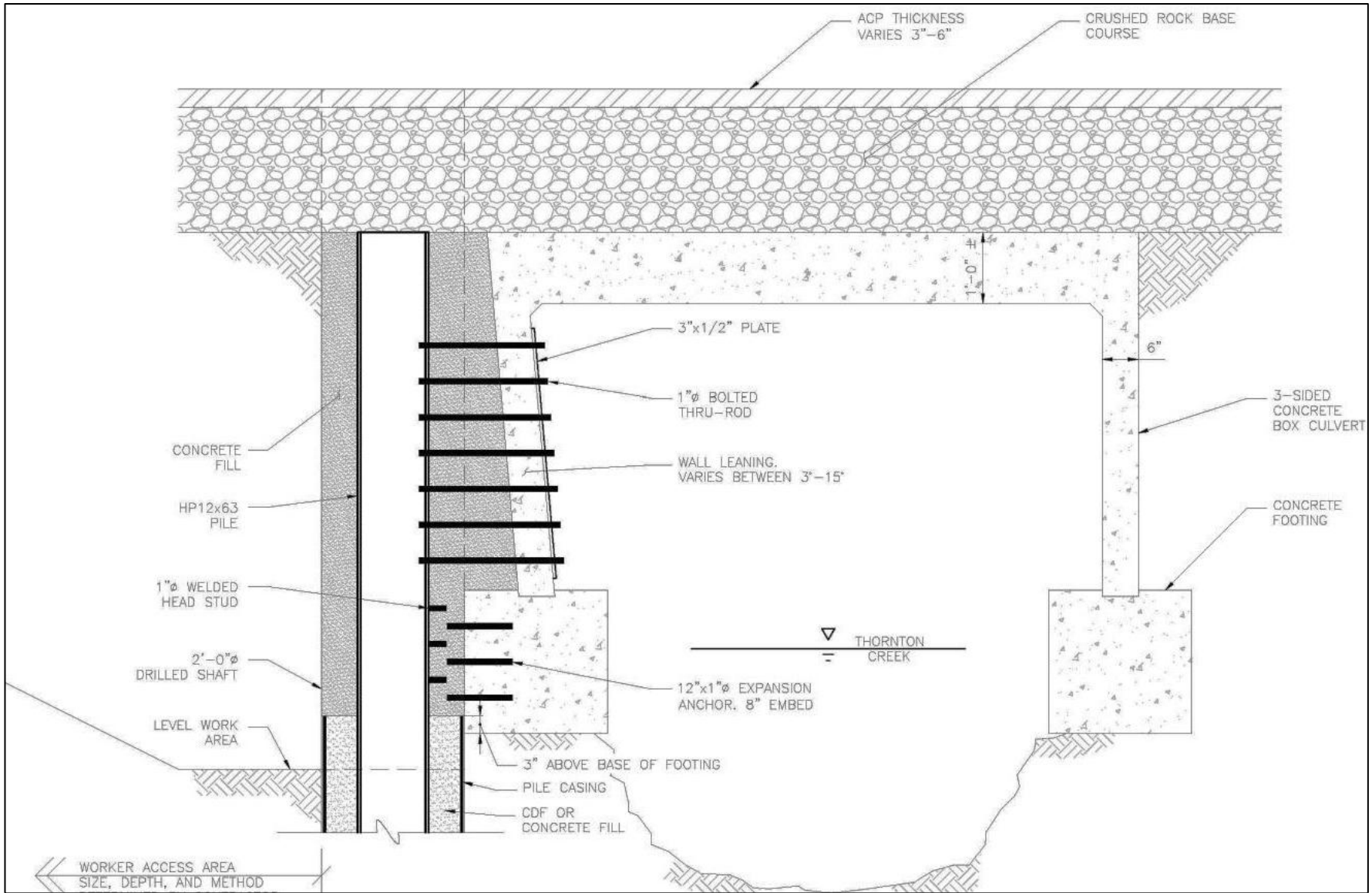

Figure 3 – Preliminary Sketch – Section